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NL PT SE**(71) Applicant: **MEDRAD INC.**

**Kappa Manor II  
271 Kappa Drive  
Pittsburgh Pennsylvania 15238(US)**

(72) Inventor: **Reilly, David M.**

**2318 Middle Road  
Glwenshaw, Pennsylvania 15116(US)**

Inventor: **Havrilla, Joseph B.**

**104 Crestwood Drive  
Pittsburgh, Pennsylvania 15209(US)**

Inventor: **Gelblum, Eugene A.**

**1111 E. Carson Street  
Pittsburgh, Pennsylvania 15203(US)**

Inventor: **Kazousky, Daniel**

**766 William Drive  
Trafford, Pennsylvania 15085(US)**

(74) Representative: **Zinnecker, Armin, Dipl.-Ing. et al**

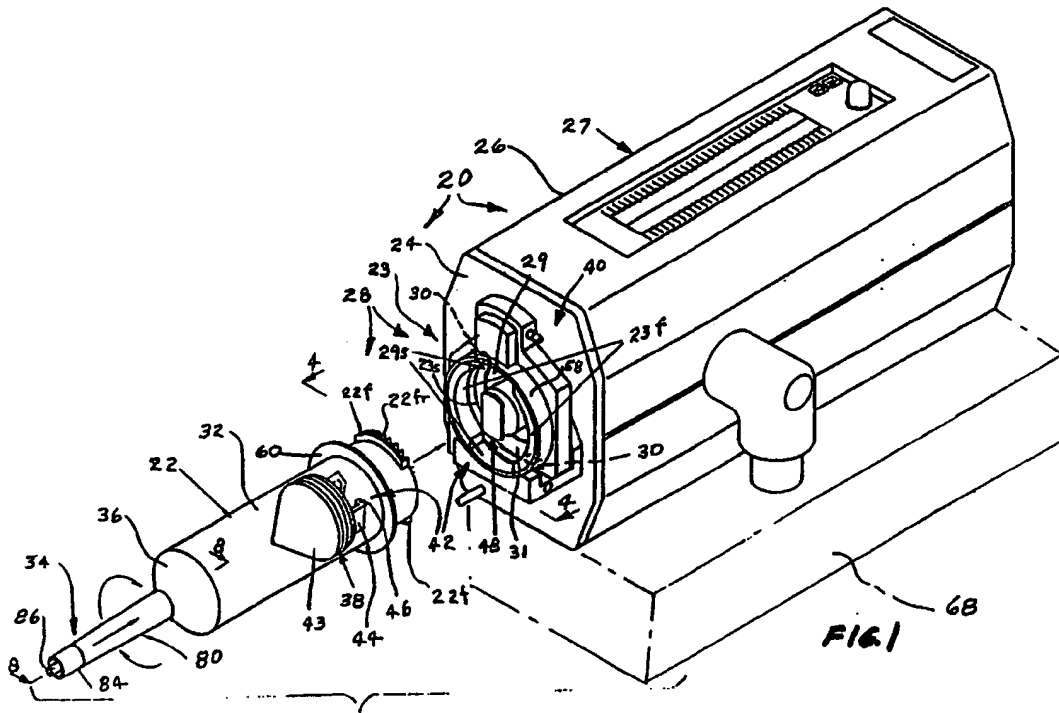
**Lorenz-Seidler-Gossel,  
Widenmayerstrasse 23  
D-80538 München (DE)**

(54) **Front-loading medical injector and syringe for use therewith.**

(57) A front-loading syringe which comprises a movable plunger for injecting liquid contrast media, is rotatably mountable on a front wall of an injector housing with an interference fit and in sealed relationship with respect thereto, with or without a pressure jacket, by a first-quick release mechanism. At the same time, the plunger is connected to an injector drive mechanism by a second readily releasable mechanism. During the mounting operation, a sensor reads injection information from an indicator device on the syringe and feeds it to an injector control. An

audible-and-tactile indicating mechanism also is activated when the syringe is essentially in the desired mounted position. The syringe may include reinforcing ribs which also function as volumetric gradations, and liquid media presence-or-absence indicating dots which appear circular against a liquid media background and oval-shaped against an air background. An injection end of the syringe comprises an injector portion of reduced diameter inside a screw-threaded attachment portion of larger diameter, and may include loop-shaped reinforcing handle portions.

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## BACKGROUND OF THE INVENTION

### FIELD OF THE INVENTION

This invention relates to a front-loading medical injector and a syringe for use therewith, and more particularly to a front-loading medical injector apparatus wherein a syringe of special construction is mountable upon and removable from a front wall of an injector housing by a first readily releasable mechanism, while a plunger in the syringe is simultaneously connected to or disassembled from an injector drive member by a second readily releasable mechanism.

### DESCRIPTION OF THE PRIOR ART

U.S. Patent No. 4,006,736, issued to R.J. Kranys et al. on February 8, 1977, and entitled, "Angiographic Injector", which is assigned to the same Assignee as the subject application, discloses an angiographic injector apparatus for injecting contrast media into the vascular system of an animal, in which angiographic syringes are rear-loaded into a pressure jacket of the injector. More specifically, the apparatus comprises a rotatable turret which carries a pair of the pressure jackets and which is rotatable so that when one of the pressure jackets, into which an angiographic syringe has been rear-loaded, is in an injection position, the other pressure jacket is in a position in which an associated angiographic syringe can be rear-loaded. Subsequently, when injection of contrast media from the first syringe is completed, the turret is rotated to move the first syringe to an unloading-loading position, with the second pressure jacket and the angiographic syringe then being moved into the injection position. In this apparatus, when each of the pressure jackets and its associated syringe has been located in the injection position, a drive member of the injector is moved forward to become drivingly engaged with a plunger in the syringe; however, the manner of engagement between the drive member and plunger is such that the drive member cannot be retracted without also retracting the plunger, which can cause body fluids of the animal to be retracted into the syringe unless the syringe is first disconnected from the animal.

An improved apparatus over the apparatus as disclosed in the Kranys et al. patent, is disclosed in U.S. Patent No. 4,677,980, issued to D.M. Reilly et al. on July 7, 1987, and entitled "Angiographic Injector and Angiographic Syringe for Use Therewith", which also is assigned to the same Assignee as the subject application. In this apparatus, a drive member of the angiographic injector can be drivingly connected to, or disconnected from, a plunger

of an angiographic syringe at any point along the path of travel of the plunger by a readily releasable mechanism. Thus, the apparatus of the Reilly et al. patent represented certain improvements over the Kranys et al. patent. However, the apparatus of the Reilly et al. patent, like that of the Kranys et al. patent, is of a rear-loading type comprising a pair of pressure jackets mounted upon a rotatable turret for moving the pressure jackets and syringes therein between injection and loading positions.

Accordingly, a need exists for a front-loading medical injector and a syringe of special construction so that the syringe can be readily and securely front-loaded directly and accurately in a desired position on the injector, thereby facilitating the loading-unloading operation, and a primary purpose of this invention is to provide such an arrangement with its various attendant advantages. Further, in certain instances, it is desirable that the syringe not be enclosed in a pressure jacket, in order that an operator be able to view the status of the syringe visually during an injection operation. By allowing the operator to see the syringe, the operator can, e.g., determine whether the syringe is empty or full, determine if it is being filled too fast and/or introducing too many air bubbles, when the syringe is filled, and the amount of contrast that has been delivered or remains in the syringe during a procedure. Another purpose of this invention is, in one embodiment, to provide an injector apparatus of such construction.

### SUMMARY OF THE INVENTION

In general, in accordance with the invention, a readily releasable mechanism is provided for supporting a syringe on a front wall of an injector housing for an injection operation. For this purpose, the readily releasable mechanism includes at least one retaining portion on the mounting mechanism releasably engageable with a mating retaining portion on the syringe. Further, an actuating mechanism of the injector includes a drive member which is connectable to a plunger in the syringe for controlling the movement of the plunger in the syringe.

More specifically, the readily releasable mechanism is an interlocking mechanism which is activated and released upon rotation of a rearward portion of the syringe relative to the front wall of the injector housing. At the same time, a second readily releasable interlocking mechanism for connecting the injector drive member to the syringe plunger, and which also is activated and released upon rotation of the syringe relative to the front wall of the housing, interconnects the drive member and the plunger. The first readily releasable mechanism may comprise a mounting mechanism

on the front wall of the housing having at least a pair of slots for receiving retaining flanges on the rearward end of the syringe therethrough, with the syringe then being rotated to engage the flanges behind associated retaining flanges of the mounting mechanism. The second readily releasable mechanism comprises respective radially projecting parts on the drive member and the plunger which become drivingly engaged in a similar manner upon rotation of the syringe and the plunger.

The first readily releasable mechanism may be further defined by the mounting mechanism on the injector housing front wall having an annular sealing member against which a resilient annular sealing member on the syringe becomes seated as the syringe is positioned on the mounting mechanism, with the resilient annular sealing member and the retaining flanges on the syringe receiving the retaining flanges on the mounting mechanism therebetween with an interference fit. An audible-and-tactile indicator mechanism, alignment arrows, and/or alignment dots also may be provided to detect when the syringe has been essentially rotated into its desired mounted position against suitable stops, with this mechanism then further functioning to discourage reverse rotation of the syringe on the injector housing. An indicator mechanism for providing liquid media injection information to an injector controller, and a sensor for reading the indicating mechanism, also may be provided on the syringe and the injector housing, respectively. The syringe also may include a mechanism which provides a visual indication of whether the syringe still includes injection liquid, may have an injector nozzle of reduced diameter surrounded by a screw-threaded cylindrical attachment portion at its injection end (the reduced diameter nozzle serving to minimize the amount of contrast that remains in the syringe after the plunger has been fully extended), may be provided with reinforcing ribs which are longitudinally spaced so as to also function as volumetric gradations, and/or may be formed of relatively strong clear plastic.

In another embodiment of the invention, which utilizes a pressure jacket, the pressure jacket is in the form of an elongated tube having one end mounted on the front wall of the injector housing, and having an opposite open outer end. In a syringe mounting operation, a syringe is inserted into the open end of the tubular jacket until an inner end of the syringe engages against a seat mechanism on the injector housing front wall. During this insertion operation, retaining flanges adjacent the forward end of the syringe pass through slots in the open end of the tubular pressure jacket, whereupon the syringe is rotated to engage the flanges behind corresponding mating retaining flanges at the open end of the jacket. As the syringe is rotated, a

plunger in the syringe also rotates into driving engagement with a drive member of the injector. An outer injection end of the syringe also may be provided with reinforcing-handle members.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partial, isometric view of an injector apparatus in accordance with the invention, showing an injector housing and a syringe in disassembled relationship;

Fig. 2 is an enlarged isometric view of portions of the apparatus shown in Fig. 1, more specifically illustrating certain features of the invention;

Fig. 3 is a partial, cross-sectional view, taken essentially along the line 3-3 in Fig. 1, illustrating the injector housing and the syringe in assembled relationship;

Fig. 4 is an end view, as seen essentially along the line 4-4 in Fig. 1, illustrating features of the syringe;

Fig. 5 is an isometric view of a modified form of the syringe shown in Fig. 1;

Fig. 6 is an enlarged isometric view of the syringe shown in Fig. 1, illustrating another feature of the invention;

Fig. 7 is an isometric view of portions of the apparatus shown in Fig. 1 in a different orientation, illustrating a further feature of the invention;

Fig. 8 is a cross-sectional view taken essentially along the line 8-8 in Fig. 1, illustrating another feature of the invention;

Fig. 9 is an isometric view similar to Fig. 1, illustrating an embodiment of the invention utilizing a pressure jacket, with an injector drive member and a syringe plunger in a retracted loading position; and

Fig. 10 is an isometric view similar to Fig. 9, illustrating the apparatus of the pressure jacket embodiment with the injector drive member and the syringe plunger in an advanced loading position.

## DESCRIPTION OF THE DISCLOSED EMBODIMENTS

Fig. 1 discloses a injector apparatus 20 of the general type disclosed in the U.S. Patents Nos. 4,006,736 to R.J. Kranys et al. and 4,677,980 to D.M. Reilly et al., for injecting a liquid contrast media into a vascular system of an animal, but of front-loading construction, rather than rear-loading construction, as disclosed in those patents. Thus, the apparatus of Fig. 1 utilizes a syringe 22 capable of being front-loaded into a mounting assembly 23 on a front wall 24 of a housing 26 of an injector 27 by a first readily releasable mechanism 28, and also capable of functioning in a injection

operation without the use of a pressure jacket, whereas each apparatus of those patents is of a type in which angiographic syringes are rear-loaded into respective pressure jackets supported on a rotatable turret for moving the jackets between injection and loading positions. However, to the extent not inconsistent with this disclosure, the disclosures of those two patents, which both are assigned to Medrad Inc, of Pittsburgh, Pennsylvania, the Assignee of the subject application, are hereby incorporated by reference.

With reference to Figs. 1-3 and the first readily releasable mechanism 28, the mounting assembly 23 on the front wall 24 of the injector housing 26 is provided with an essentially cylindrical opening 29 for receiving a rearward end of the syringe 22. The opening 29 includes a pair of upper and lower slots 29s (best shown in Fig. 2) through which respective upper and lower retaining flanges 22f of the syringe 22, having reinforcing ribs 22fr, may pass as the rearward end of the syringe is inserted in the opening. The mounting assembly 23 further includes opposed retaining flanges 23f on opposite sides thereof so that, after the rearward end of the syringe 22 has been inserted into the opening 29, and the syringe is rotated clockwise, as viewed in Fig. 1, the retaining flanges 22f on the syringe become engaged behind the retaining flanges 23f to secure the syringe to the housing front wall 24. During this mounting of the syringe 22 on the housing front wall 24, the rotation of the syringe preferably is limited by suitable rearwardly projecting stops 30 at adjacent ends of the housing front wall retaining flanges 23f. The mounting assembly 23 also includes an inner annular ring 31 in spaced relationship to the retaining flanges 23f, to provide support for the rearward end of the syringe 22 and also define semi-annular guide slots 23s (best shown in Fig. 2) for receiving the syringe flanges 22f.

As is disclosed in the aforementioned D.M. Reilly et al U.S. Patent No. 4,677,980, and referring again to Fig. 1, the syringe 22 comprises an elongated main tubular body or barrel 32 and a coaxial discharge injection section 34, interconnected by an intermediate conical portion 36. A plunger 38 is slidably positioned within the tubular body 32 and is connectable to an actuating mechanism 40 in the injector housing 26 by a second readily releasable mechanism 42. The second readily releasable mechanism 42 is formed in part by the plunger 38 comprising a base member 43 having hook or lug members 44 (Figs. 1, 3 and 4) extending rearwardly therefrom, with portions 46 of these members extending radially inward in opposed relationship. The plunger 38 serves to control the ejection of fluid contained within the syringe 22 in a desired quantity and at a desired rate, and the hook mem-

bers 44 are designed to facilitate axial movement of the plunger in either direction when connected to the actuating mechanism 40 by the second readily releasable mechanism 42.

Further in this connection, as is best shown in Figs. 2 and 3, the actuating mechanism 40, which reciprocates the plunger 38 in the syringe tubular body 32, comprises a reciprocable drive member 48 which includes a base portion 50, a stem 52 (Fig. 3) and an integral rectangular head 54 extending radially outward from the stem, all of which form additional parts of the second readily releasable mechanism 42. The drive member 48, however, while reciprocable, is not rotatable, as disclosed in the above-mentioned Reilly et al patent. Rather, as the syringe 22 is inserted into the opening 29 in the mounting assembly 23, the hook members 44 (Fig. 3) on the plunger 38 initially move past the rectangular head 54 on the drive member 48 on opposite sides thereof into alignment with the stem 52 and slots 56 defined by the rectangular head and the base portion 50. Then, when the syringe 22 is rotated clockwise to engage the syringe retaining flanges 22f behind the retaining flanges 23f of the mounting assembly 23, the radially extending portions 46 of the hook members simultaneously move into the slots 56 to effect a driving engagement between the plunger 38 and the drive member 48 in either a forward or reverse direction, as is best shown in Fig. 3.

With further reference to Figs. 1-3, the mounting assembly 23 further includes a forwardly projecting annular ring or collar 58 which functions to remove extra slack in the mounting slots and assure perpendicular engagement between the plunger 38 and the drive member 48, as well as for sealing. The retaining flanges 23f are mounted within the annular ring 58. As is illustrated in Fig. 2, the tubular body 32 of the syringe 22 also includes a resilient annular sealing ring 60 surrounding the tubular body and disposed forward of the syringe retaining flanges 22f a preselected distance D1 essentially equal to a thickness D2 of the mounting assembly retaining flanges 23f. Thus, when the syringe 22 is inserted into the opening 29 in the mounting assembly 23 until the syringe sealing ring 60 engages the annular ring 58, and is then rotated to engage the syringe retaining flanges 22f behind the retaining flanges 23f, the latter flanges are received between the syringe retaining flanges and the resilient syringe sealing ring with an interference fit. For this purpose, the retaining flanges 23f may be provided with a slight lead-in taper (not shown) to facilitate initial movement thereof between the syringe retaining flanges 22f and the resilient sealing ring 60.

The foregoing mounting arrangement possesses a number of advantages, including minimiz-

ing wobble and rotation of the syringe 22 during an injection operation, preventing unwanted rotational disengagement of the syringe from the injector housing 26, by creating a controlled sliding friction interference fit, preventing contrast media spilled from the injecting end of the syringe, from flowing into the injector housing 26, as illustrated in Fig. 7, and eliminating the need for constructing the respective parts to excessively tight tolerances. This tight-fitting mounting of the syringe 22 on the housing front wall 24 is further facilitated by providing the syringe retaining flanges 22f with the reinforcing ribs 22fr (Figs. 1, 2 and 4) to enhance their structural rigidity. To enhance the sealing capability of the annular rings 58 and 60, a suitable O-ring (not shown) also may be provided therebetween.

Referring again to Fig. 2, in the disclosed embodiment of the invention, the resilient annular sealing ring 60 on the syringe 22 and at least one of the retaining flanges 23f of the mounting assembly 23 include respective parts which form an audible-and-tactile indicating mechanism 64 for detecting and indicating when the syringe and its plunger 38 have essentially been rotated into a desired mounted position against the stops 30. More specifically, the retaining flange 23f includes an arcuate slot 23fs formed in a front surface thereof for receiving a projection 65 on the syringe sealing flange 60 as the syringe is rotated relative to the injector housing front wall 24. The slot 22fs further includes a protuberance 66 spaced slightly from one end of the slot so that this protuberance is engaged by the projection 65 on the syringe sealing ring 60 during rotation of the syringe toward its mounted position, with this engagement providing an audible and tactile feedback indicating that the syringe is essentially in the mounted position. Then, as the syringe 22 continues to be rotated into its mounted position, the projection 65 on the syringe annular sealing ring 60 rides over the protuberance 66 in the slot 22fs and into a small space between the protuberance and the end of the slot, just before the retaining flanges 22f on the syringe engage their respective stops 30. The protuberance 66 in the slot 22fs then cooperates with the projection 65 to prevent undesired reverse rotation of the syringe 22 out of its mounted position. In the alternative, this arrangement may be reversed, with a slot-protuberance arrangement being provided on the syringe annular sealing ring 60, and a projection being provided on the one retaining flange 23f of the injector housing front wall mounting assembly 23. Moreover, although this embodiment describes the use of a projection and slot, one should recognize that other means may also accomplish the desired tactile/audible effect. Thus, for example, one may instead use a "dimple" located on the flange 60 which may snap into

a receiving hole on the retaining flange 23f.

With further reference to Fig. 2, a system 67 for transmitting syringe information from the syringe 22 to an injector controller 68, illustrated in phantom lines in Fig. 1, while attaching the syringe to the injector housing front wall mounting assembly 23, also is provided. In this instance, the system 67 comprises an encoding device 70, such as a bar code having spaced bars 70b and located on the syringe 22, and a sensor 72 located on the injector 27, as for example, in a second one of the connector assembly retaining flanges 23f. Then, as the syringe 22 is rotated into its mounted position, the sensor 72 reads the encoding device 70 and forwards associated signals to the injector controller 68, which then interprets the signals and modifies the function of the injector apparatus 20 accordingly. Examples of the information which could be encoded on the encoding device 70 include dimensions of the syringe 22, content of the syringe in the case of a pre-filled syringe, manufacturing information such as lot numbers, dates and tool cavity number, recommended contrast media flow rates and pressures, and loading/injection sequences. As an alternative to the encoding device 70 being a bar code with spaced bars 70b, the encoding device also could include raised surfaces 70s corresponding to the spaced bars, which then would be read by a suitable injector sensor 72 in a similar manner, as the syringe 22 is mounted on the injector housing front wall 24. In addition to the encoding device 70, one may also use mechanically readable devices, e.g. a slot, hole, or projection on the syringe 22 or plunger 38 to register against a switch on the mounting assembly 23, or alternatively an optically readable device, e.g. characters, dots and other geometric shapes, that will send information concerning the type of syringe used to the intelligent circuits of the injector.

Referring to Fig. 5, since the syringe 22 is being used in this embodiment without a pressure jacket, for strength and visibility of the syringe contents, the syringe wall may be formed of a clear PET polyester material. In the alternative, the wall of the syringe 22 may be formed of polypropylene reinforced by providing a series of annular ribs 74 on the tubular body 32 of the syringe in longitudinally spaced relationship. Further, by suitably spacing the ribs 74 along the length of the tubular body 32, such as in equal increments, the ribs also can perform the dual function of serving as volumetric gradations for the purpose of indicating the amount of contrast media in the syringe 22.

With reference to Fig. 6, the tubular body 32 of the syringe 22 also may be provided with an indicating mechanism 76 for readily detecting the presence or absence of a liquid contrast media in the syringe. In this instance, the detecting mecha-

nism 76 includes a plurality of integrally molded, textured dots 78 on the syringe 22, which provide a visual indication of whether the syringe contains liquid or air. More specifically, as illustrated in Figs. 6 and 7, when viewed against an air background (Fig. 7), the dots 78 appear oval-shaped, but when viewed against a liquid contrast media background (Fig. 6), which has a different index of refraction than air, the dots 78 appear circular.

Fig. 8 illustrates the internal construction of the syringe discharge injection section 34. Specifically, while a rearward portion 80 of the injection section 34 is of tapered conical construction, a forward connector portion 82 is of generally cylindrical construction and formed with internal screw threads 84 for attaching a catheter (not shown) to the injection section. Further, an injection nozzle 86 of reduced diameter is disposed within the screw-threaded cylindrical connector portion 82 and is integrally molded with the tapered rearward portion 80 of the injection section adjacent the point at which the tapered and cylindrical portions merge together.

Figs. 9 and 10 disclose an alternate embodiment of the invention in which a front-loading syringe 22' is mounted on a front wall 24' of a housing 26' of an injector 27' in conjunction with a pressure jacket 88, preferably formed of a strong clear plastic, such as polycarbonate. The pressure jacket 88 is in the form of an elongated tubular member which is suitably mounted at its rearward end in a mounting assembly 23' on the housing front wall 24', by fitting the flange of pressure jacket 88 into the collar on the mounting assembly 23'. The pressure jacket 88 also has a forward open end 90 for receiving the syringe 22'.

Thus, in this embodiment, a pair of opposed inwardly projecting retaining flanges 88f, separated by opposed slots 88s, are provided adjacent the forward open end of the pressure jacket 88, rather than in the mounting assembly 23' on the injector housing front wall 24' as in the embodiment of Figs. 1-8. Similarly, a tubular body 32' of the syringe 22' also includes a pair of outwardly projecting retaining flanges 22f' (only one shown) on opposite sides thereof, but in this instance located adjacent the forward end of the tubular body, rather than adjacent its rearward end, as in the embodiment of Figs. 1-8. In addition, at the forward end of the syringe 22', on opposite sides of a discharge injection section 34', a pair of reinforcing, loop-shaped handle portions 92, for facilitating handling of the syringe, including rotation thereof, are integrally molded with the injection section and a tapered conical intermediate portion 36'. In other respects, while not specifically disclosed and described, it is to be understood that various other features of the embodiment of the invention disclosed in Figs. 1-8, may be incorporated into the

embodiment of Figs. 9 and 10, as desired.

In use, the syringe 22' of Figs. 9 and 10 may be mounted in the pressure jacket 88 with a drive member 48' of the injector 27' either in a retracted position, as shown in Fig. 9, or in an advanced position, as shown in Fig. 10. For example, with the drive member 48' in the retracted position, as shown in Fig. 9, a plunger 38' is disposed at the rearward end of the syringe 22'. The syringe 22' then is inserted into the open end 90 in the forward end of the pressure jacket 88 until the rearward face of the retaining flanges 22f' have engaged against suitable seat members in the pressure jacket 88, with hook members 44' of the syringe plunger 38' having moved beyond a rectangular head 54' of the drive member 48' and into alignment with associated slots 56' in the drive member. At the same time, the retaining flanges 22f' on the syringe 22' have moved through the slots 88s at the forward end of the pressure jacket 88 into positions rearward of the retaining flanges 88f adjacent the opening 90 in the pressure jacket. The syringe 22' then is rotated clockwise in Fig. 9, using the handles 92, to move radially projecting portions 46' of the hook members 44' on the syringe plunger 38' into the slots 56' of the drive member 48', and to simultaneously move the retaining flanges 22f' on the syringe into engagement behind their respective retaining flanges 88f on the pressure jacket 88.

In Fig. 10, in which the injector drive member 48' is in a forward position, the mounting of the syringe 22' into the pressure jacket 88 is the same as shown in Fig. 9, except that the plunger 38' also is in its forward position in the syringe. In other respects, the mounting of the syringe 22' on the pressure jacket 88 is essentially the same as previously described for Fig. 9. However, having the syringe plunger 38' and the drive member 48' in their forward positions, as shown in Fig. 10, has several advantages over the rearward position arrangement of Fig. 9, from a time standpoint. For example, since the syringe plunger 38' and the drive member 48' are already in their forward positions, it is not necessary to move them forward in preparation for a syringe-filling operation; rather, the plunger and the drive member can immediately be retracted for this purpose. Similarly, after an injection operation has been completed, additional time is saved by not having to retract the plunger 38' and the drive member 48' in preparation for a next injection operation. Further, this embodiment prevents the drive member 48' from touching or contaminating the inner wall of syringe 22'.

In summary, a new and improved system by which an injection syringe, such as the syringe 22 in the embodiment of Figs. 1-8, readily can be mounted upon and/or removed from the front wall

24 of the injector housing 26, has been disclosed. For this purpose, the first readily releasable mechanism 28, by which the syringe 22 is attached to or removed from the injector housing front wall 26, and the second readily releasable mechanism 42, by which the plunger 38 of the syringe is drivingly connected to or released from the drive member 48 of the injector 27 cooperate to produce their respective connections and disconnections simultaneously. Another advantage is that the plunger 38 is capable of being placed in a driven or undriven state at any point along its path, whereby the syringe 22 may be disengaged from the injector 27 without having to retract the drive member, or having to first disconnect the syringe from an animal being injected before retracting the drive member.

Other desirable features of the invention include the construction of the first readily releasable mechanism 28, in which the syringe 22 is mounted upon the front wall 24 of the injector housing 26 with an interference friction fit, which is advantageous from the standpoint of minimizing syringe wobble and reverse rotation (disengagement) during an injection operation, and eliminating the need for excessively tight manufacturing tolerances. Proper mounting of the syringe 22 and prevention of disengagement also is facilitated by the audible-and-tactile detecting mechanism 64. The encoding device 70 on the syringe 22, in cooperation with the sensor 72 on the injector 27, also is advantageous from the standpoint of providing "custom programming" of the injector as the syringe is mounted thereon. Elimination of a pressure jacket also is desirable from the standpoint of better visibility of the contents of the syringe 22, better heat transfer to the syringe contents and decreased cleaning and maintenance otherwise needed due to, e.g., scratching or contamination with contrast media of the pressure jacket.

In order to eliminate the need for a pressure jacket, the syringe 22 also may be made of a relatively strong clear plastic, or may be provided with the annular reinforcing ribs 74, which also are spaced to function as volumetric gradations, as disclosed in Fig. 5. Further, the detection of the presence of liquid in the syringe 22 is facilitated by the indicating mechanism 76 in Fig. 6, in the form of the dots 78 molded into the syringe tubular body 32, with the dots appearing visually as either oval-shaped or circular, depending upon whether the tubular body contains air or liquid, respectively. In addition to functioning as a part of the first readily releasable mechanism 28 for the syringe 22, the syringe resilient annular flange 60 also cooperates with the annular ring 58 to create a seal to prevent contrast media spilled from the injection end of the syringe, from flowing into the injector housing 26,

as shown in Fig. 7. The embodiment of the invention shown in Figs. 9 and 10 also provides a system by which various other advantages, including time savings in syringe-filling and syringe-changing operations, can be achieved utilizing a pressure jacket, such as the pressure jacket 88 mounted in the connector assembly 23' on the injector housing front wall 24'.

While the injector apparatus of the present invention is especially designed for injection, it may be applicable to other systems, angiographic and otherwise. It is therefore understood that the foregoing description and accompanying drawings set forth the preferred embodiments of the invention at the present time. Various modifications, additions and alternative designs will, of course, become apparent to those skilled in the art in light of the foregoing teachings without departing from the spirit and scope of the disclosed invention. Thus, it should be appreciated that the invention is not limited to the disclosed embodiments but may be practiced within the full scope of the appended claims.

## Claims

1. An injector for injecting a liquid from a syringe, said injector comprising:
  - a housing having a front wall;
  - readily releasable mounting means on said housing front wall for supporting the syringe for an injection operation, said readily releasable mounting means including retaining means for releasably engaging a retaining portion on the syringe; and
  - drive means in said housing movable through said housing front wall for controlling the movement of the plunger in the syringe.
2. The injector as recited in claim 1, which further comprises second readily releasable means for releasably connecting said drive means to the plunger of the syringe.
3. The injector as recited in claim 1, wherein said readily releasable mounting means is an interlocking mechanism which is activated and released upon rotation of the syringe relative to the front wall of said housing.
4. The injector as recited in claim 3, which further comprises second readily releasable means for releasably connecting said drive means to the plunger of the syringe, said second readily releasable means comprising a driving portion on said drive means which releasably engages with a mating driven portion on the plunger of the syringe, and said second readily releasable



means also being an interlocking mechanism which is activated and released upon rotation of the syringe relative to the front wall of said housing.

5. The injector as recited in claim 4, wherein the mating portions of said second readily releasable means are respective radially projecting portions on said drive means and the plunger of the syringe.
6. The injector as recited in claim 5, wherein said radially projecting portions can be engaged or disengaged at any point along the drive path of said drive means.
7. The injector as recited in claim 1, wherein said readily releasable mounting means includes slot means for receiving the retaining portion on the syringe therethrough, with said retaining means of said readily releasable mounting means having an inner surface means for engaging the retaining portion on the syringe when the syringe is inserted into and rotated in said readily releasable mounting means.
8. The injector as recited in claim 7, which further comprises:
  - annular sealing means on the front wall of said housing for engaging annular sealing means on the syringe, for perpendicularly aligning the plunger and the drive means and for minimizing slack between the syringe and the slot means.
9. The injector as recited in claim 7, wherein said retaining portion on the syringe is located adjacent a rearward end of the syringe.
10. The injector as recited in claim 9, wherein said retaining portion on the syringe is a flange having reinforcing ribs.
11. The injector as recited in claim 1, which further comprises:
  - a tubular pressure jacket having a rearward end mounted on the front wall of said housing and having a forward open end for receiving the syringe therethrough for connection of the syringe plunger to said drive means; and
  - said retaining means of said readily releasable mounting means being on said pressure jacket adjacent the forward open end thereof, with said retaining portion on the syringe also being adjacent a forward end thereof.
12. The injector as recited in claim 11, wherein said pressure jacket includes inner slotted means for receiving said retaining portion on the syringe therethrough, so that said syringe retaining portion and an inner surface of said retaining means on said pressure jacket can be engaged upon rotation of the syringe in said pressure jacket.
13. The injector as recited in claim 1, which further comprises:
  - stop means for preventing over-rotation of the syringe as the syringe is rotated into a mounted position.
14. The injector as recited in claim 1, which further comprises:
  - annular sealing means on the front wall of said housing for engaging annular sealing means on the syringe, for preventing spilled liquid from a discharge end of the syringe from flowing rearward along the syringe into said injector housing.
15. The injector as recited in claim 14, wherein said retaining means of said readily releasable means is received between the annular sealing means and the retaining portion on the syringe with an interference fit.
16. The injector as recited in claim 15, wherein the annular sealing means on the syringe is of resilient construction to facilitate said interference fit.
17. The injector as recited in claim 1, wherein the syringe is formed of clear plastic.
18. The injector as recited in claim 1, wherein the syringe has spaced reinforcing ribs on an outer surface thereof.
19. The injector as recited in claim 18, wherein said reinforcing ribs encircle the syringe and are longitudinally spaced so as to also function as volumetric gradations.
20. The injector as recited in claim 1, which further comprises audible-and-tactile and visual indicating means for detecting when the syringe has been mounted in a desired position on the front wall of said housing.
21. The injector as recited in claim 20, wherein said audible-and-tactile and visual indicating means comprises a slot or a projection associated with said housing, which cooperates with a syringe projection or a slot in the sy-

ringe, respectively, as the syringe is moved into a mounted position, with said slot having another projection therein engageable by said first-mentioned projection to provide an audible-and-tactile and visual indication.

22. The injector as recited in claim 1, which further comprises:

means for controlling the operation of said injector; and

sensor means for reading liquid media injection information from an indicator device on the syringe as the syringe is mounted on said housing front wall, and for feeding the information to said control means.

23. The injector as recited in claim 22, wherein said sensor means is for reading a bar code indicator device.

24. The injector as recited in claim 22, wherein said sensor means is for reading an indicator device in the form of a preselected pattern of raised and depressed portions.

25. The injector as recited in claim 1, which further comprises detecting means formed with said syringe for indicating the presence or absence of a liquid media in said syringe, said detecting means providing a different visual shape when the liquid media is present then when the liquid media is absent.

26. The injector as recited in claim 25, wherein said indicator means is in the form of dots which appear circular when the liquid media is present and which appear oval-shaped when the liquid media is absent.

27. The injector as recited in claim 1, wherein said syringe includes an elongated injection section which includes a screw-threaded cylindrical attachment portion surrounding an injector portion of a reduced diameter.

28. The injector as recited in claim 1, wherein said syringe includes an elongated injection section and at least one reinforcing-handle portion extending along one side of said injection section.

29. The injector as recited in claim 6, which further comprises:

annular sealing means on the front wall of said housing for engaging a resilient annular sealing portion of the syringe when the syringe is mounted on said housing;

said retaining means of said first-men-

tioned readily releasable means being received between said annular sealing portion and said retaining portion on said syringe with an interference fit when said syringe is mounted on the front wall of said housing;

audible-and-tactile indicating means for detecting when the syringe has been rotated into a desired mounted position relative to said housing front wall; and

sensor means for reading liquid media injection information from an indicator device on the syringe as the syringe is mounted on said housing front wall, and feeding the information to an injector control system.

30. A front-loading syringe for injecting a liquid media, which comprises:

an elongated cylindrical main body of relatively large uniform diameter;

readily releasable mounting means on said cylindrical main body for mounting the syringe in a desired position relative to a front wall of an injector housing;

an elongated injection section of relatively small diameter connected to a forward end of said cylindrical main body; and

a plunger movably mounted in said cylindrical main body for forcing the liquid media from the syringe through said injection section.

31. The front-loading syringe as recited in claim 30, wherein said readily releasable mounting means includes at least one radially projecting flange on said cylindrical main body.

32. The front-loading syringe as recited in claim 31, wherein said at least one radially projecting retaining flange extends only partially around the periphery of said cylindrical main body.

33. The front-loading syringe as recited in claim 31, wherein said at least one radially projecting retaining flange includes reinforcing ribs.

34. The front-loading syringe as recited in claim 31, wherein said readily releasable mounting means includes at least two radially projecting retaining flanges in spaced relationship on said cylindrical main body.

35. The front-loading syringe as recited in claim 34, wherein said radially projecting retaining flanges include reinforcing ribs.

36. The front-loading syringe as recited in claim 31, wherein said at least one radially projecting retaining flange is located adjacent a rearward end of said cylindrical main body.

37. The front-loading syringe as recited in claim 31, wherein said at least one radially projecting retaining flange is located adjacent a forward end of said cylindrical main body.

38. The front-loading syringe as recited in claim 31, wherein said plunger also includes readily releasable means for connecting said plunger to a plunger drive member in the injector housing.

39. The front-loading syringe as recited in claim 30, which further comprises a circumferentially extending and radially projecting sealing flange on said cylindrical main body.

40. The front-loading syringe as recited in claim 31, which further comprises a circumferentially extending and radially projecting sealing flange on said cylindrical main body in a preselected spaced relationship from said at least one radially projecting retaining flange and cooperable therewith for mounting the syringe on the injector housing with an interference fit.

41. The front-loading syringe as recited in claim 40, wherein said sealing flange is of resilient construction to facilitate said interference fit.

42. The front-loading syringe as recited in claim 30, wherein said syringe is formed of clear plastic.

43. The front-loading syringe as recited in claim 30, wherein said cylindrical main body includes a plurality of spaced reinforcing ribs.

44. The front-loading syringe as recited in claim 43, wherein said reinforcing ribs encircle said cylindrical main body and are longitudinally spaced so as to also function as volumetric gradations.

45. The front-loading syringe as recited in claim 30, which further comprises audible-and-tactile indicating means on said cylindrical main body for detecting when said syringe has been essentially located in a desired position relative to said injector housing front wall.

46. The front-loading syringe as recited in claim 45, wherein said audible-and-tactile indicating means includes a projection or slot adapted to cooperate with a slot or a projection, respectively, on the injector housing, said slot also including another projection engageable by said first-mentioned projection to provide an audible-and-tactile indication.

47. The front-loading syringe as recited in claim 30, which further comprises indicator means for providing liquid media injection information to a control system for an injector.

48. The front-loading syringe as recited in claim 47, wherein said indicator means is a bar code.

49. The front-loading syringe as recited in claim 47, wherein said indicator means is a preselected pattern of raised and depressed surface portions.

50. The front-loading syringe as recited in claim 30, which further comprises indicator means formed in said syringe for indicating the presence or absence of liquid media in said syringe, said indicator means providing a different visual shape when the liquid media is present than when the liquid media is absent.

51. The front-loading syringe as recited in claim 50, wherein said indicator means is in the form of dots which appear circular when the liquid media is present and which appear oval-shaped when the liquid media is absent.

52. The front-loading syringe as recited in claim 30, wherein the injection section includes a screw-threaded cylindrical attachment portion surrounding an injector portion of reduced diameter.

53. The front-loading syringe as recited in claim 30, which further comprises at least one reinforcing-handle portion extending along one side of said injection section.

54. The front-loading syringe as recited in claim 31, which further comprises:

second readily releasable means on said plunger for connecting said plunger to a plunger drive member in said injector housing;

a circumferentially extending and radially projecting sealing flange of resilient construction on said cylindrical main body in a preselected spaced relationship from said at least one radially projecting retaining flange and cooperable therewith for mounting the syringe on said injector housing with an interference fit;

audible-and-tactile indicating means on said cylindrical main body for detecting when said syringe has been located in a desired mounted position; and

indicator means on said cylindrical main body for providing liquid media injection information to said injector as said syringe is

mounted on said injector.

55. Apparatus for injecting a liquid media, which comprises:

a front-loading syringe for holding the liquid media;

an injector housing having a front wall;

readily releasable mounting means for supporting said front-loading syringe on said housing front wall for an injection operation; and

drive means movable through said housing front wall for controlling the movement of said plunger in said syringe.

56. Apparatus as recited in claim 55, which further comprises a second readily releasable means for interconnecting said drive means and said plunger.

57. Apparatus as recited in claim 55, wherein said readily releasable mounting means is an interlocking mechanism which is activated and released upon rotation of said syringe relative to the front wall of said housing.

58. Apparatus as recited in claim 57, which further comprises a second readily releasable means for interconnecting said drive means and said plunger, said readily releasable means also being an interlocking mechanism which is activated and released upon rotation of said syringe relative to the front wall of said housing.

59. Apparatus as recited in claim 58, wherein said second readily releasable means comprises at least one radially projecting portion on said drive means engageable by a mating radially projecting portion on said plunger as said syringe and said plunger therein are rotated relative to said housing front wall.

60. Apparatus as recited in claim 59, wherein said radially projecting portions can be engaged or disengaged at any point along the drive path of said drive means.

61. Apparatus as recited in claim 55, wherein said readily releasable mounting means includes slot means on said housing front wall for receiving at least one retaining portion on said syringe therethrough, said retaining portion on said syringe being releasably engageable with a retaining portion on said housing front wall when said syringe is rotated relative to said housing front wall.

62. Apparatus as recited in claim 61, wherein said retaining portion on said syringe is located adjacent a rearward end of said syringe.

63. Apparatus as recited in claim 61, wherein said retaining portion on said syringe is a flange having reinforcing ribs.

64. Apparatus as recited in claim 55, which further comprises:

a tubular pressure jacket having a rearward end mounted on the front wall of said housing and having a forward open end;

said syringe being insertable through the forward open end of said tubular pressure jacket into said jacket for connection to said drive means; and

said readily releasable mounting means including at least one syringe retaining portion on said pressure jacket adjacent the forward open end thereof, and at least one mating syringe retaining portion on said syringe adjacent a forward end thereof.

65. Apparatus as recited in claim 64, wherein said pressure jacket includes inner slot means for receiving said at least one mating retaining portion on said syringe therethrough, so that said retaining portions can be interengaged upon relative rotation of said syringe in said pressure jacket.

66. Apparatus as recited in claim 55, which further comprises:

stop means for preventing over-rotation of said syringe as said syringe is rotated into a mounted position.

67. Apparatus as recited in claim 55, which further comprises:

annular sealing means on the front wall of said housing for engaging annular sealing means on said syringe adjacent a rearward end thereof, for preventing spilled liquid media from a discharge end of said syringe from flowing rearward along said syringe into said injector housing.

68. Apparatus as recited in claim 67, wherein said readily releasable mounting means includes a retaining flange on said housing front wall which is received between said annular sealing means on said syringe and a retaining flange on said syringe with an interference fit.

69. Apparatus as recited in claim 68, wherein said annular sealing means on said syringe is a flange of resilient construction to facilitate said

interference fit.

70. Apparatus as recited in claim 55, wherein said syringe is formed of clear plastic.

71. Apparatus as recited in claim 55, which further comprises spaced reinforcing ribs on said syringe.

72. Apparatus as recited in claim 71, wherein said reinforcing ribs encircle said syringe and are longitudinally spaced so as to also function as volumetric gradations.

73. Apparatus as recited in claim 55, which further comprises audible-and-tactile indicating means for detecting when said syringe has been mounted in a desired position on said housing front wall.

74. Apparatus as recited in claim 73, wherein said audible-and-tactile indicating means comprises a slot in either said housing or said syringe, for receiving a first projection on said syringe or said housing, respectively, as said syringe is moved into its mounted position, with said slot including a second projection therein engageable by said first projection to provide an audible-and-tactile indication.

75. Apparatus as recited in claim 55, which further comprises:

means for controlling the operation of the apparatus;

indicator means on said syringe for providing liquid media injection information to said control means; and

sensor means on said housing front wall for reading said indicator means as said syringe is mounted on said housing front wall.

76. Apparatus as recited in claim 75, wherein said indicating means is a bar code.

77. Apparatus as recited in claim 76, wherein said indicating means is a preselected pattern of raised and depressed portions.

78. Apparatus as recited in claim 55, which further comprises detecting means formed with said syringe for indicating the presence or absence of liquid media in said syringe, said detecting means providing a different visual shape when the liquid media is present than when the liquid media is absent.

79. Apparatus as recited in claim 78, wherein said indicator means is in the form of dots which

appear circular when the liquid media is present and which appear oval-shaped when the liquid media is absent.

80. Apparatus as recited in claim 55, wherein said syringe includes an elongated injection section which includes a screw-threaded cylindrical attachment portion surrounding an injector portion of a reduced diameter.

81. Apparatus as recited in claim 55, wherein said syringe includes an elongated injection section and at least one reinforcing-handle portion extending along one side of said injection section.

82. Apparatus as recited in claim 60, which further comprises:

annular sealing means on the front wall of said housing for engaging a resilient annular sealing member on said syringe;

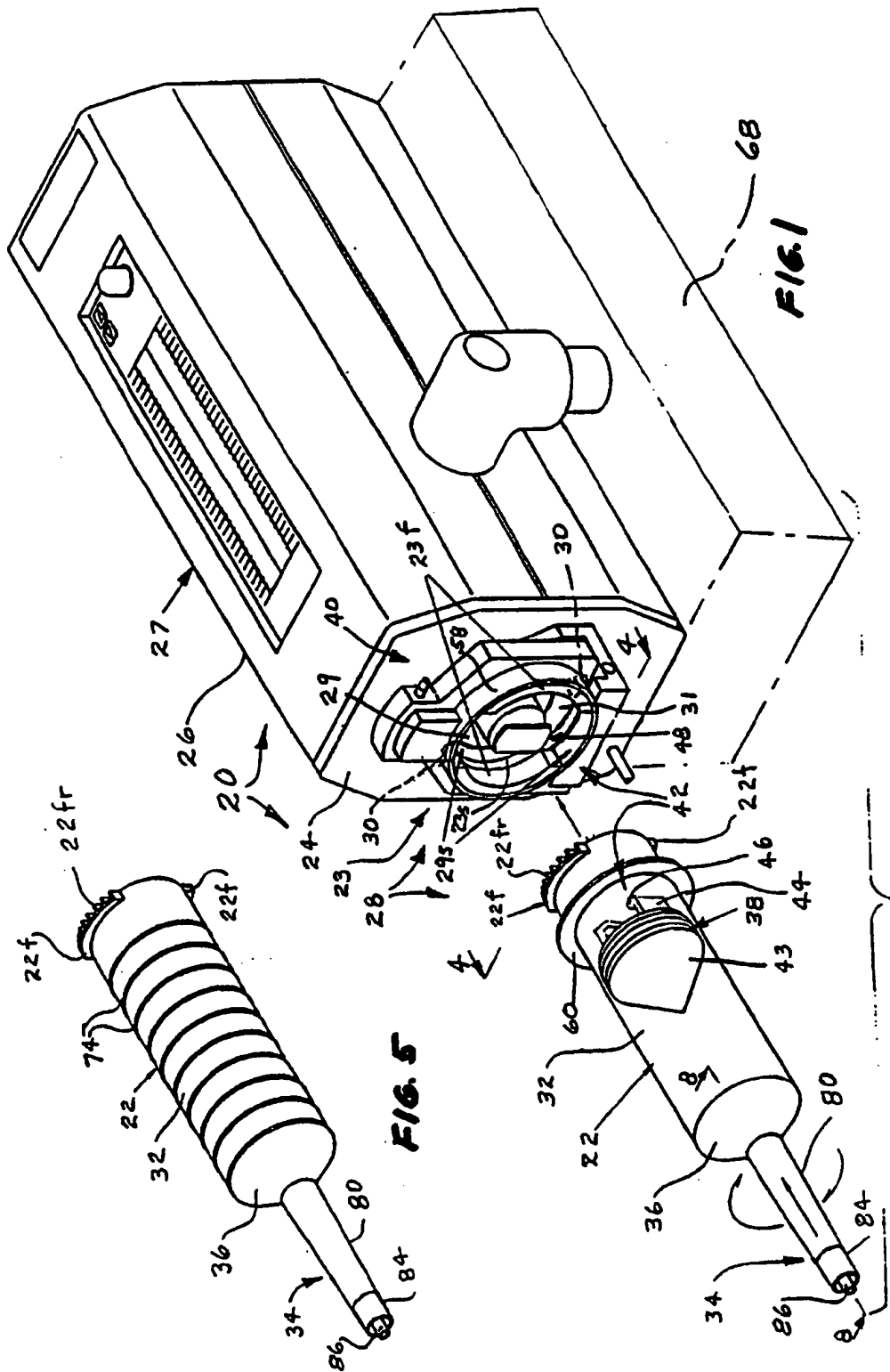
said readily releasable mounting means including a syringe retaining flange on said housing front wall received between a retaining flange on said syringe and said resilient annular sealing member on said syringe with an interference fit;

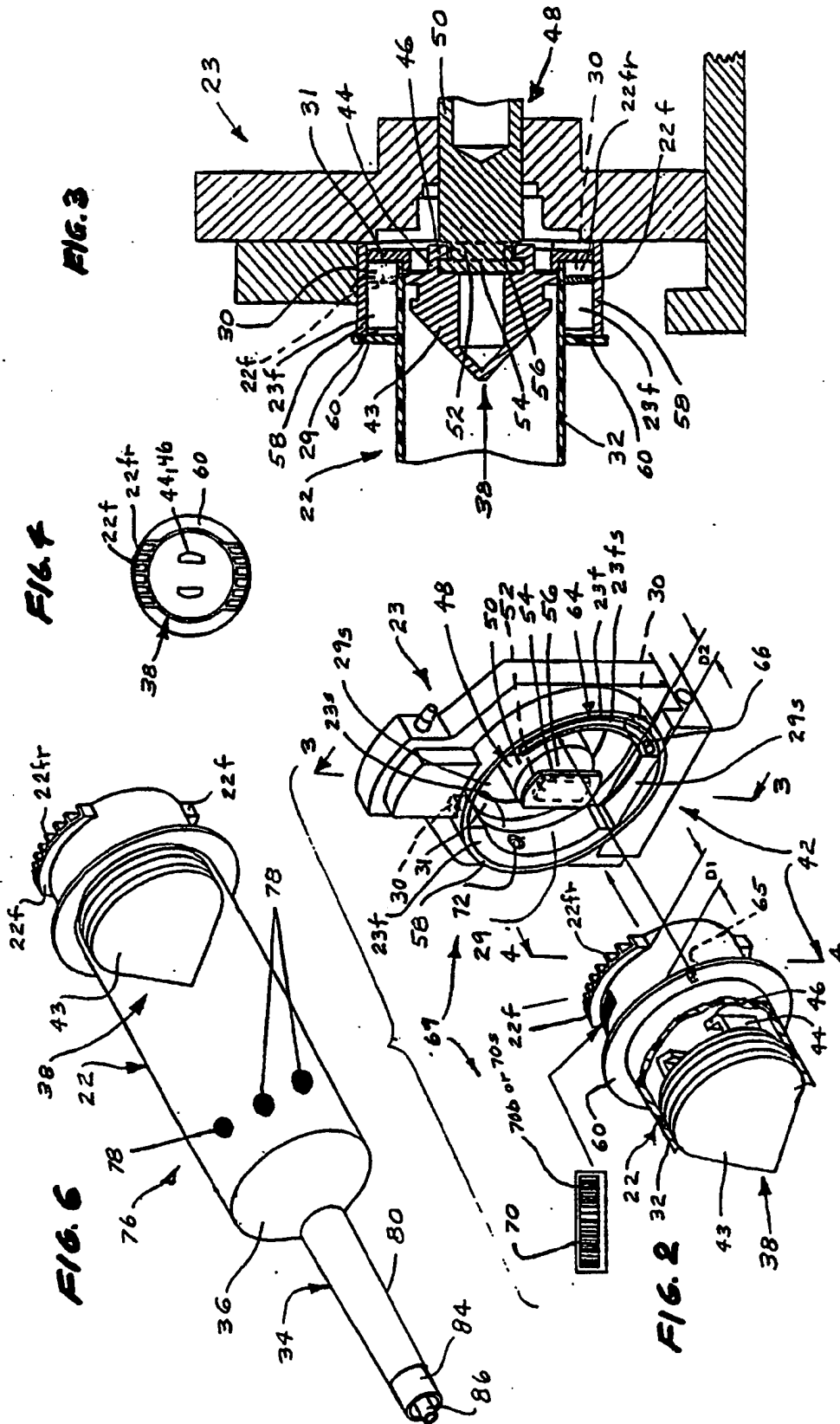
audible-and-tactile indicating means for detecting when said syringe has been rotated into a desired position on said housing front wall;

means for controlling the operation of the apparatus;

indicator means on said syringe for providing liquid media injection information for the operation of said control means; and

sensor means on said housing front wall for reading said indicator means as said syringe is mounted on said housing front wall, and for feeding the information to said control means.





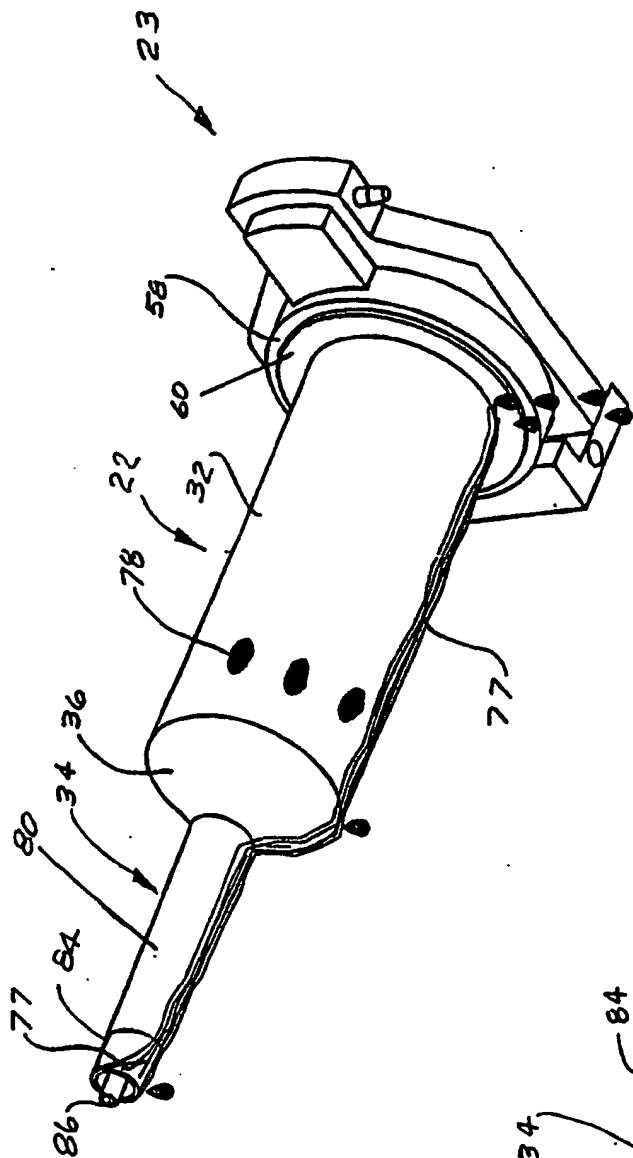


FIG. 7

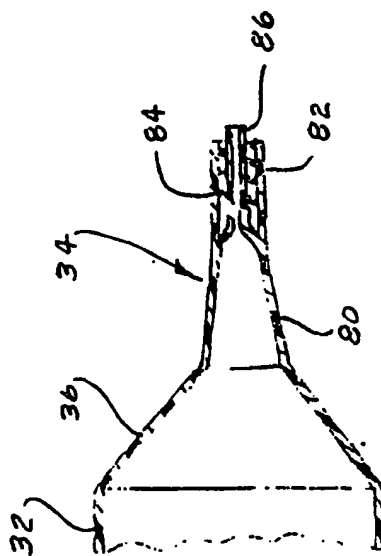


FIG. 8



